U. S. Department of Agriculture, Forest Service

FOREST PRODUCTS LABORATORY

In cooperation with the University of Wisconsin

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EFFECT OF STORAGE ON THE MOISTURE CONTENT OF LUMBER

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The fullest efficiency and satisfaction to be derived from the use of wood in any construction are in large part dependent upon its moisture content at the time of installation. If lumber manufacturers and retail dealers sell only good and dry lumber, there is no apparent reason why a larger demand for wood products will not be forthcoming.

It has been the practice at some mills to machine and ship thoroughly seasoned lumber to wholesale and retail yards only to have it there stored in piles unprotected from the weather. Such practice largely offsets the benefits of proper seasoning because the wood may absorb moisture to an undesirable extent before it is used. In order to obtain definite information upon the effect of storage on the moisture content of lumber the Forest Products Laboratory recently made a survey of storage methods at sawmills, at wholesale and retail distributing yards, and at wood-using plants in various parts of the United States.

Results of Survey

Illustrative of the results obtained is figure 1, relating to a study at a Louisiana sawmill. Somewhat similar results were obtained at a Florida sawmill and at several distributing yards in the vicinity of Chicago. In the case of the Louisiana mill the stock was southern yellow pine 1 by 4-inch by 12-foot flooring and 1 by 8-inch by 12-foot boards surfaced four sides and solid piled, that is, piled without stickers. A group of boards selected by means of a moisture meter for uniformity of moisture content was piled in each of the following

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

locations: (1) In a yard where the pile was well protected by a tight roof, (2) in a partly open shed with metal roof, (3) in an open shed with wood roof, and (4) in a closed shed with a wood roof. Each curve in figure 1 represents the changes in average moisture content of 80 boards.

It may be noted that the average moisture content values, which were initially about 7.5 percent, ranged between 10 and 11 percent after 10 months in the three sheds. In the yard the average moisture content reached 13.5 percent during the same period. These are average values; the ends and other surfaces of the boards exposed directly to the air would have moisture content values higher than the average. The relatively large absorption of moisture at the ends is objectionable either in the rough lumber or in a finished product such as flooring. In the rough lumber the boards will have a uniform width only at the time of machining; subsequently the ends will shrink and will be narrower than the remaining portions of the boards. In a finished product, assuming that the boards are fairly uniform in moisture content when machined, subsequent absorption of moisture mostly at the ends will cause the ends to be wider than they should be.

Control of Moisture Content

To prevent such undesirable changes in moisture content as just described, it is necessary to provide some means of controlling the moisture conditions to which the lumber is exposed during storage. As in a dry kiln, the control of moisture content within the shed is a matter of temperature and relative humidity, and this is comparatively simple. Control of the relative humidity in a storage shed can be accomplished by controlling the temperature.

Referring to figure 2, it may be noted, for example, that at the average indoor temperature of 70° F. and relative humidity of 42 percent the equilibrium moisture content of wood is 8 percent. This means that for the most satisfactory service such products as flooring and interior finishing woodwork in heated dwellings in most parts of the United States should be installed at about 8 percent moisture content.

Let us suppose that in an unheated shed the temperature and relative humidity are respectively 30° F. and 75 percent. According to figure 2 the corresponding equilibrium moisture content is 15 percent. If the shed is tightly constructed so that no extraneous sources of moisture are present, the equilibrium moisture content can be reduced to 8 percent by merely heating the air in the shed to about 45° F. (See dotted line in fig. 2.) In this way steam sprays, water sprays, or refrigeration are not required. Further, the heat loss under this condition is less than if a common temperature of, say, 60° or 70° were maintained.

Throughout a considerable range of temperature and relative humidity a fairly constant difference in temperature will give a desired reduction in equilibrium moisture content. To apply this principle an instrument called a differential thermostat was constructed with two mercury-filled control bulbs. One bulb was placed outdoors and the other inside a tightly-constructed shed about 10 feet wide, 20 feet long, and 10 feet high. The instrument could be so adjusted that if the outdoor temperature dropped or rose, the inside temperature would drop or rise about the same number of degrees; in other words, the difference between outside and inside temperatures remained constant. The thermostat opened and closed a valve on a 1/2-inch steam line carrying 75 pounds pressure. The steam line extended along one side of the shed about 14 inches above the floor. A wallboard guard was fixed in position about 2-1/2 inches from the pipe and parallel to it, for the dual purpose of increasing the natural upward air movement over the pipe and of protecting lumber near it from excessive heat. Six thin pieces of wood were placed in the shed to serve as indicators of the variation in moisture content in different parts.

It may be noted in figure 3 that during the period October 2, 1933, to August 9, 1934, the average moisture content values inside the shed varied from about 7.8 to 9.1 percent whereas the moisture content values outside varied from 7.8 to 20.6 percent. At any one time the moisture content near the ceiling was about 1-1/2 percent less than that near the floor in the shed. No steam was required during May and June because of the low outdoor relative humidity.

Summation

Stock seasoned to low moisture content values should be stored in heated sheds. The average moisture content of seasoned stock stored within tightly constructed sheds can be satisfactorily maintained through the use of relatively inexpensive equipment.

Whether an unheated shed is closed or nearly closed makes little difference in its effect on the average moisture content changes of the stock stored within. Storage in an unheated insulated or lined compartment is but little better than in an uninsulated compartment provided the stock is protected from the ground moisture by means of a floor or by an ample ventilating space beneath the pile.

The interior of a solid pile of dry lumber in storage for 7 months in either an open or closed unheated shed absorbed very little moisture, but the ends change in moisture content quite readily with changes in air conditions. This end pick-up may cause an appreciable increase in width at the ends. Overhanging ends are objectionable in this

respect. On account of the heat of the sun and the cooling effect of the ground, storage in the upper part of a shed is better than near the ground for minimizing changes in the moisture content of upper-grade stock.

Solid-piled flooring in sheds, during a period of 1-1/2 years, picked up from 1-1/2 to 2 percent more moisture than did stock surfaced on four sides. In the yard where the wind had a chance to act this difference was 3-1/2 percent. The cut ends of oak flooring boards which were butted together within a pile 12 feet long picked up no more moisture than the adjacent uncut sections. In storing stock of low moisture content, such as hardwood flooring, the pile should be as big and solid as practicable because the interior of a pile changes in moisture content very slowly.

Southern yellow pine shiplap picked up moisture more rapidly than did Douglas fir flooring. This is apparently a species effect, but may be due partly to the fact that the southern yellow pine was about 50 percent sapwood whereas the Douglas fir was practically all heartwood. The difference in moisture content of the two species was approximately 1 percent during most of the storage period.

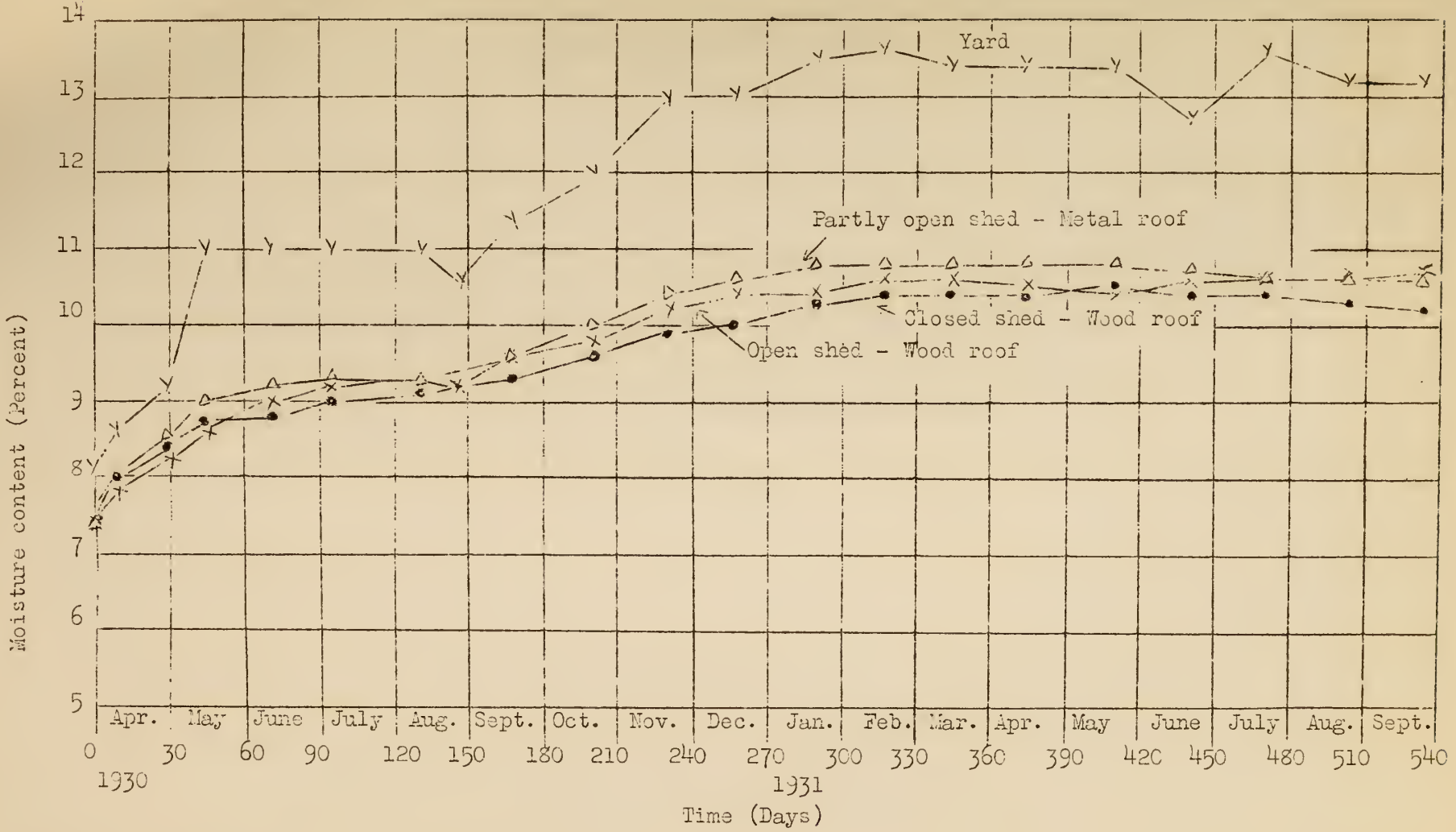

Figure 1.--Average moisture content changes in southern yellow pine 1 by 4 inch flooring and 1 by 8 inch boards surfaced four sides, stored in a solid pile in each of four different locations.

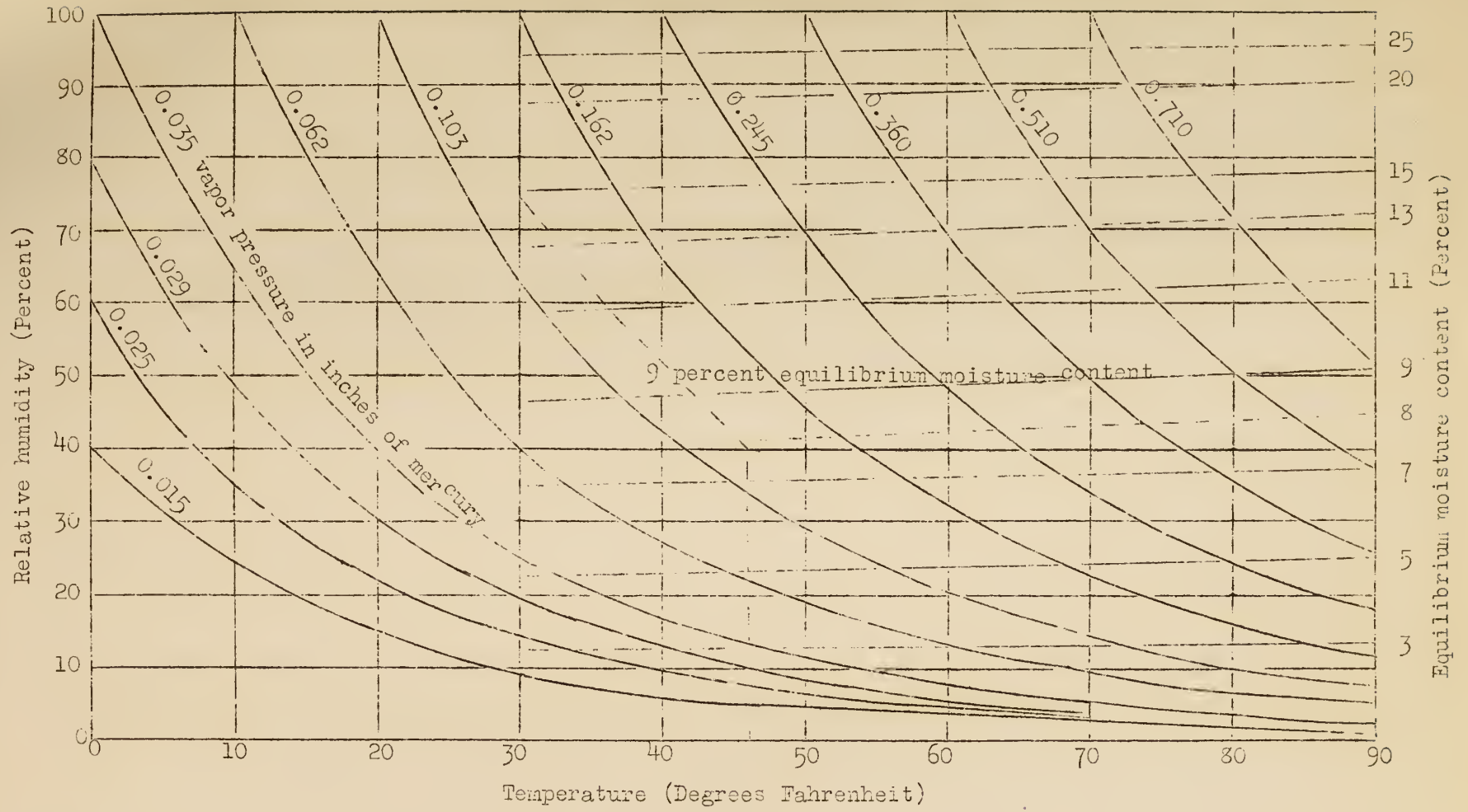

Figure 2.--Relation of the equilibrium moisture content of wood to the temperature and relative humidity of the surrounding atmosphere. (Dotted line illustrates the example cited.)

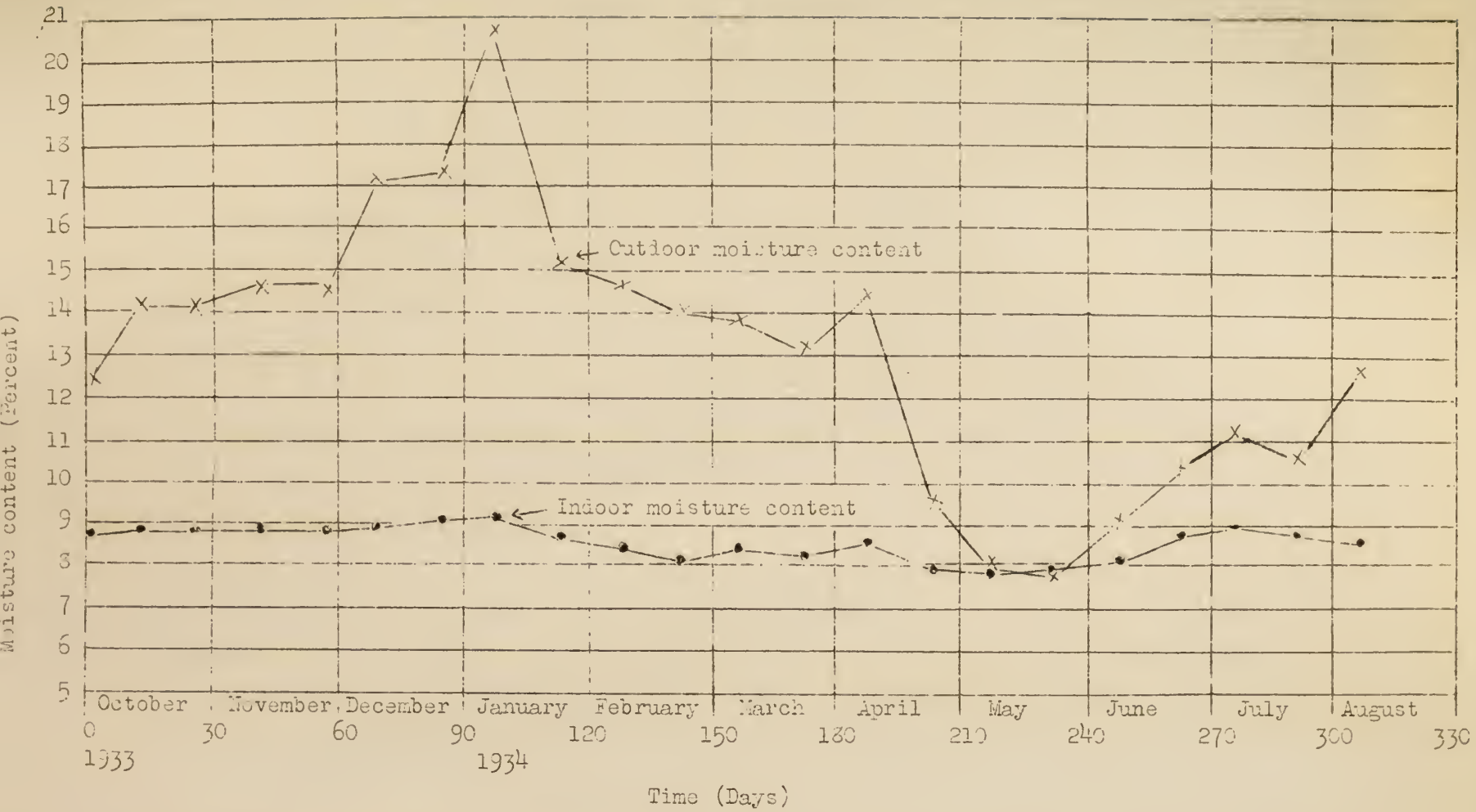

Figure 3.--Moisture content changes inside and outside the storage shed.